Estimating the effect of pioneering on market share of industrial goods manufacturers (SAS)

Dataset PIMS.dat has data on industrial goods manufacturers. The variables in the data are in the following order. These variables and definitions are given in the paper by Robinson and Fornell (1985) on pioneering advantages (see Tables 1, 2 and 3). As in the paper by Robinson and Fornell (1985), we will estimate a simultaneous system of five equations. While the paper considered consumer goods industries, we are interested in replicating the analysis for industrial goods industries.

MS	Relative market share
QUAL	Relative quality
PRICE	Relative price
PLB	Product line width
DC	Relative direct costs
PION	Whether a firm is a pioneer (1) or not (0)
EF	Whether a firm is an early follower (1) or not (0)
PHPF	Pioneer *high purchase frequency
PLPF	Pioneer *low purchase frequency
PSC	Pioneer *seasonal product change
PAPC	Pioneer *annual/periodic product change
NCOMP	Number of competitors
MKTEXP	Relative marketing expenditures (similar to 'relative advertising and promotion')
TYRP	Twenty-year pioneer
PNP	Percentage of new products
CUSTTYP	Relative customer type
NCUST	Relative Number of customers
CUSTSIZE	Relative customer size
PENEW	Plant and equipment newness
CAP	Capacity utilization
RBVI	Relative backward vertical integration
EMPRODY	Employee productivity
UNION	Percentage of employees unionized

Estimating a 2SLS model with the following five simultaneous equations.

model MS=qual plb price pion ef phpf plpf psc papc ncomp mktexp

model Qual=price dc pion ef tyrp mktexp pnp

model PLB=dc pion tyrp ef pnp custtyp ncust custsize

model Price=ms qual dc pion ef tyrp mktexp pnp

model DC=ms qual pion ef tyrp penew cap rbvi emprody union

Estimating the effect of pioneering on market share by executing 2SLS model using SAS (PROC SYSLIN)

RESULTS FROM TWO-STAGE LEAST SQUARES ESTIMATION							
Variables	**Mean**	**SD**	**Model Statistics**				
			Market Share (MS)	**Relative quality (QUAL)**	**Relative price (PRICE)**	**Product line width (PLB)**	**Relative direct costs (DC)**
Intercept (Constant)	1	0	2.95465	-20.9224	97.772***	118.5502***	1.34678***
Relative market share (MS)	24.8689	18.058			-0.012		-0.00502*
Relative quality (QUAL)	22.7404	26.294	0.123068		0.0111		0.007715
Relative price (PRICE)	103.8	6.1162	1.711649**	-0.01363			
Product line width (PLB)	102.3	7.1473	-1.40842***				
Relative direct costs (DC)	2.0909	0.7859		21.70676***	2.1208	-6.92937***	
Whether a firm is a pioneer (1) or not (0) (PION)	0.519	0.4998	7.704433***	1.777771	1.8718	2.684386	0.4026***
Whether a firm is an early follower (1) or not (0) (EF)	0.3256	0.4688	4.969807***	-4.33167*	-0.499	0.336469	0.115373*
Pioneer *high purchase frequency (PHPF)	0.157	0.3639	1.003745				
Pioneer *low purchase frequency (PLPF)	0.0225	0.1485	4.173235				
Pioneer *seasonal product change (PSC)	0.00155	0.0394	-20.9422*				
Pioneer *annual/periodic product change (PAPC)	0.0754	0.2641	0.67807				
Number of competitors (NCOMP)	2.2859	1.0592	-7.73394***				
Relative marketing expenditures (similar to 'relative advertising and promotion') (MKTEXP)	7.1239	5.5519	-0.3707**	0.175886	0.2489***		
Twenty-year pioneer (TYRP)	0.4903	0.5001		-5.13063	-2.034**	-0.44111	0.018384
Percentage of new products (PNP)	5.9587	11.41		0.241755***	0.0103	0.052638***	
Relative customer type (CUSTTYP)	2.0629	0.6346				-0.32922	

Relative Number of customers (NCUST)	5.6954	1.44				-0.12125	
Relative customer size (CUSTSIZE)	2.0653	0.5906				-0.94873**	
Plant and equipment newness (PENEW)	51.196	14.284					-0.00203
Capacity utilization (CAP)	76.6761	15.567					0.002494*
Relative backward vertical integration (RBVI)	1.9122	0.6129					0.150695***
Employee productivity (EMPRODY)	39.6422	27.12					0.001568*
Percentage of employees unionized (UNION)	49.1445	32.603					4.69E-06
	R-Square		0.27644	0.04781	0.0736	0.02805	0.08102
	Adj R-Square		0.2702	0.04259	0.0678	0.02197	0.07382

*** on parameter estimates show significance level at 1%
** on parameter estimates show significance level at 5%
* on parameter estimates show significance level at 10%

Estimating the effect of pioneering on market share:

Direct Effect of pioneering on market share
= Marginal effect of pioneering on market share as per Market Share (MS) model
= 7.704433 + 1.003745*avg (PHPF)/avg(pion) + 4.173235* avg (PLPF)/ avg(pion) -20.9422*avg (PSC)/ avg(pion) + 0.67807*avg (PAPC)/ avg(pion)

Average Values of PHPF, PLPF, PSC, PAPC and pion are as per table below:

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
phpf	phpf	1287	0.1569542	0.3638989	0	1.0000000
plpf	plpf	1287	0.0225330	0.1484669	0	1.0000000
psc	psc	1287	0.0015540	0.0394055	0	1.0000000
papc	papc	1287	0.0753691	0.2640886	0	1.0000000
pion	pion	1287	0.5190365	0.4998317	0	1.0000000

= 7.704433 + 1.003745* (0.1569542/0.5190365) + 4.173235* (0.0225330/0.5190365) - 20.9422*(0.0015540/0.5190365) + 0.67807*(0.0753691/0.5190365)
= 7.7044 + 0.3035 + 0.1812 – 0.0627 + 0.0985
= 8.2249

Indirect Effect of pioneering on market share
From Model QUAL: (Parameter of Pion on Model Qual) * (Parameter estimate of Qual on Model MS)
= 1.777771 * 0.123068 = 0.218786
From Model PRICE: (Parameter of Pion on Model PRICE) * (Parameter estimate of PRICE on Model MS)

= 1.8718 * 1.711649 = 3.203865
From Model PLB: (Parameter of Pion on Model PLB) * (Parameter estimate of PLB on Model MS)
= 2.684386 * (-1.40842) = - 3.780743
FROM Model DC: There will be no indirect effect of pioneering on market share (MS) as DC is not included in Model MS.

Hence, Overall effect of Pioneering (direct + indirect) = 8.2249 + 0.218786 + 3.203865 - 3.780743
= 7.866808

Interpretation:
This means that if a firm is a pioneer, it will have 7.87 more relative market share (MS) than those firms who are not pioneer keeping other variables constant.

Estimating the effect of pioneering on market share using OLS model and how does this effect change across different models

Root MSE	14.08664	R-Square	0.3967
Dependent Mean	24.86892	Adj R-Sq	0.3915
Coeff Var	56.64356		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	47.10577	7.93726	5.93	<.0001
qual	qual	1	0.16803	0.01669	10.07	<.0001
plb	plb	1	-0.48873	0.06034	-8.10	<.0001
price	price	1	0.33801	0.07833	4.32	<.0001
pion	pion	1	9.85044	1.23538	7.97	<.0001
ef	ef	1	4.96093	1.21283	4.09	<.0001
phpf	phpf	1	1.49996	1.20434	1.25	0.2132
plpf	plpf	1	1.15149	2.71867	0.42	0.6720
psc	psc	1	-20.89740	9.99172	-2.09	0.0367
papc	papc	1	-1.11110	1.55504	-0.71	0.4750
ncomp	ncomp	1	-7.53340	0.37779	-19.94	<.0001
mktexp	mktexp	1	-0.11006	0.07492	-1.47	0.1421

A simple regression model of market share (MS) as given in the first equation is executed.
model MS=qual plb price pion ef phpf plpf psc papc ncomp mktexp
Parameter estimate of pioneering on market share as per the above equation = 9.85044. This means that if a firm is a pioneer, it will have 9.85 more relative market share (MS) than those firms who are not

pioneer keeping other variables constant. And, variable Pioneer is significant in both the estimate outputs at 1% significant level.

Estimating effect of pioneering across different models:

model Qual=price dc pion ef tyrp mktexp pnp

Parameter estimate of pioneering on Relative quality (QUAL) as per the above equation = 3.94541, which has increased compare to 2SLS estimated outputs (as per the table above). And, it is not significant in both estimate outputs at 5% significance level.

Root MSE	23.44552	R-Square	0.2093
Dependent Mean	22.74040	Adj R-Sq	0.2049
Coeff Var	103.10071		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-151.36398	11.42674	-13.25	<.0001
price	price	1	1.54414	0.11147	13.85	<.0001
dc	dc	1	6.49891	0.86075	7.55	<.0001
pion	pion	1	3.94541	4.21808	0.94	0.3498
ef	ef	1	-2.24132	2.01991	-1.11	0.2674
tyrp	tyrp	1	-1.73610	3.97537	-0.44	0.6624
mktexp	mktexp	1	-0.22429	0.12435	-1.80	0.0715
pnp	pnp	1	0.22805	0.05857	3.89	0.0001

model PLB=dc pion tyrp ef pnp custtyp ncust custsize

Parameter estimate of pioneering on Product line width (PLB) as per the above equation = 0.04260, which has decreased compare to 2SLS estimated outputs (as per the table above). And, it is not significant in both estimate outputs at 5% significance level.

Root MSE	7.07687	R-Square	0.0257
Dependent Mean	102.33256	Adj R-Sq	0.0196
Coeff Var	6.91556		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	106.81421	1.18308	90.29	<.0001
dc	dc	1	-0.60126	0.29562	-2.03	0.0422
pion	pion	1	0.04260	1.28079	0.03	0.9735
tyrp	tyrp	1	-0.57380	1.20511	-0.48	0.6341
ef	ef	1	-0.30759	0.61041	-0.50	0.6144
pnp	pnp	1	0.04944	0.01732	2.85	0.0044
custtyp	custtyp	1	-0.19688	0.35932	-0.55	0.5838
ncust	ncust	1	-0.14375	0.13973	-1.03	0.3038
custsize	custsize	1	-0.93685	0.35555	-2.63	0.0085

model Price=ms qual dc pion ef tyrp mktexp pnp

Parameter estimate of pioneering on Relative Price (PRICE) as per the above equation = 1.59600, which has decreased slightly compare to 2SLS estimated outputs (as per the table above). And, it is not significant in both estimate outputs at 5% significance level.

Root MSE	5.48631	R-Square	0.2004
Dependent Mean	103.80412	Adj R-Sq	0.1954
Coeff Var	5.28525		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	99.86635	0.57257	174.42	<.0001
ms	ms	1	0.00200	0.00964	0.21	0.8358
qual	qual	1	0.08416	0.00631	13.35	<.0001
dc	dc	1	0.14462	0.21215	0.68	0.4956
pion	pion	1	1.59600	1.00132	1.59	0.1112
ef	ef	1	-0.21941	0.47549	-0.46	0.6446
tyrp	tyrp	1	-1.53193	0.93238	-1.64	0.1006
mktexp	mktexp	1	0.24010	0.02850	8.42	<.0001
pnp	pnp	1	-0.00746	0.01379	-0.54	0.5886

model DC=ms qual pion ef tyrp penew cap rbvi emprody union

Parameter estimate of pioneering on Relative direct costs (DC) as per the above equation = 0.11925, which has decreased slightly compare to 2SLS estimated outputs (as per the table above). However, it is significant in 2SLS estimate output of model DC at 1% significance level but not for the above model.

Root MSE	0.71977	R-Square	0.1678
Dependent Mean	2.09091	Adj R-Sq	0.1613
Coeff Var	34.42375		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	1.31568	0.14945	8.80	<.0001
ms	ms	1	0.01044	0.00124	8.42	<.0001
qual	qual	1	0.00435	0.00081847	5.32	<.0001
pion	pion	1	0.11925	0.13202	0.90	0.3665
ef	ef	1	0.02826	0.06285	0.45	0.6530
tyrp	tyrp	1	0.12543	0.12325	1.02	0.3090
penew	penew	1	-0.00162	0.00143	-1.13	0.2584
cap	cap	1	0.00153	0.00131	1.17	0.2438
rbvi	rbvi	1	0.11433	0.03336	3.43	0.0006
emprody	emprody	1	0.00035727	0.00075384	0.47	0.6356
union	union	1	0.00033331	0.00063398	0.53	0.5992